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FUNGOUS DISEASES
AND SPRAYING

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The Knapsack Sprayer

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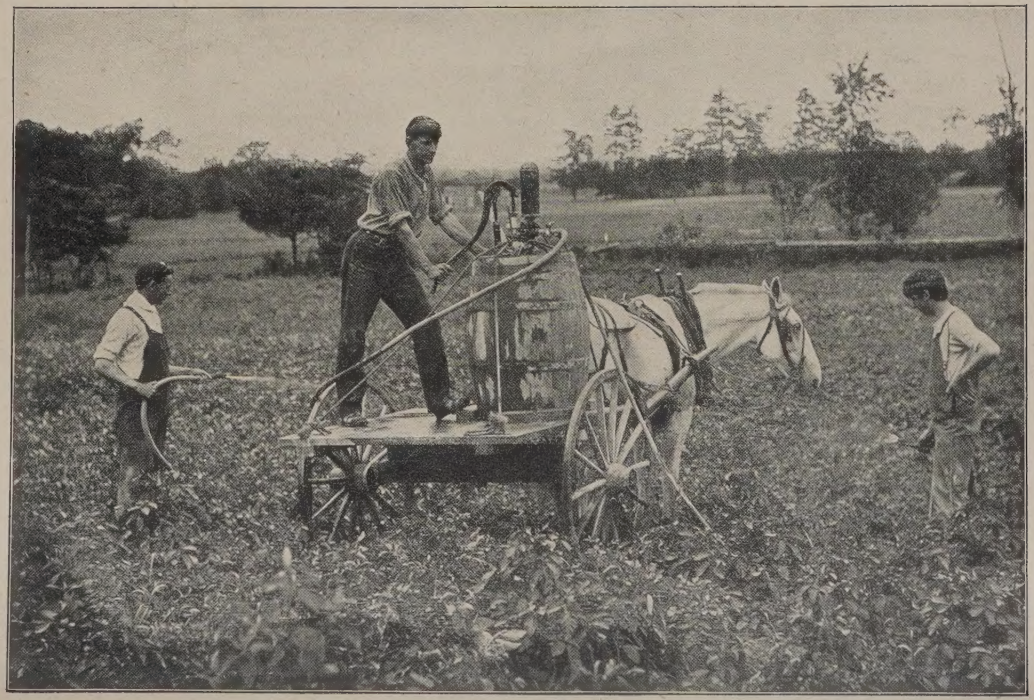

Spraying Potatoes

FUNGOUS DISEASES AND SPRAYING

H. H. LAMSON

It is important to have a clear idea of the nature of fungous diseases. The impression we have received in talking with many upon the subject would seem to warrant beginning with the statement that: *Fungous diseases are not caused by insects.* They are caused by the *growth of one plant upon another.* The plant which causes the disease is called a parasite and belongs to the class of plants known as fungi. These parasites are microscopic in size, so that it is not strange that their nature is not generally familiar. The plant on which the parasite grows and produces disease is called the host plant. Most of the agricultural plants serve as hosts for several or many different species of fungi and are seriously injured thereby. Figures might be given which would show that the aggregate loss to agriculture from this cause is enormous.

A fungus, like other plants, consists of a nutritive or vegetative part and a reproductive part. The vegetative part, in fungi called mycelium, grows on or in the tissues of the host plant and draws its food from them just as the host gets its nourishment from the soil, and in so doing produces the injury which constitutes the disease. Upon the vegetative part there develops sooner or later the reproductive part, consisting of spores and structures on or in which they are produced. The spores perform the same office for the fungus that seeds do for the host plant; they are produced in great numbers and are scattered by the wind.

The fundamental principle in the treatment of fungous diseases is to prevent the infection of the host plant by the spores. The most practical way of doing this is to apply to the plant to be protected some subtance which will kill the

spores before or immediately after they germinate without injuring the host plant. Such a substance is called a *fungicide*. The method of application is usually by spraying.

Fungicides. Only a few of the more useful fungicides will be considered here.

Copper sulphate (common names, blue vitriol, blue stone) is the most generally used fungicidal substance; it is used both in a simple solution and as the basis of Bordeaux mixture.

The simple solution is made by dissolving one pound in twenty-five gallons of water. This is useful for disinfecting trees and shrubs when not in foliage.

The simple solution of blue vitriol when applied to leaves or other green parts of plants will cause "burning"; the addition of lime to the solution will prevent this injury. This combination is called Bordeaux mixture.

The following is a good formula for the Bordeaux mixture:

Blue vitriol . . .	5 lbs.
Lime (fresh) . . .	5 lbs.
Water	50 gallons.

Dissolve the vitriol in water, hot water will do it more rapidly; slack the lime; dilute each with as much water as can be done conveniently, the more the better, then mix and stir thoroughly.

If much spraying is to be done, considerable time may be saved by making a stock solution of blue vitriol. If this is made of such strength that two quarts contain one pound it can be measured readily; the quantity required for a barrel of the mixture will be two and one half gallons. The lime also may be slacked beforehand provided it is kept covered with water until used. In this condition, however, the lime is not so conveniently measured; a good way is to use a test to determine when sufficient lime has been used. If a little yellow prussiate of potash is dissolved in water and a few drops added to the Bordeaux mixture no change will be noted, beyond perhaps a slight yellow color, if enough lime has been used; if, however, too little has been used, a brown color will appear and more lime must be added; a small excess of lime will do no harm. An ounce of the yellow prussiate, which may be

obtained at the drug store, in enough water to dissolve it will serve for a large number of tests.

A good outfit for making the mixture consists of two half-barrels, a gallon, and a quart measure of copper, and wooden pails. If the copper measures seem expensive, a pail marked for gallons and a glass fruit jar marked for quarts may be used. For filling the pump barrel, a wide-mouthed tunnel will be a great convenience; this may be of tin though better of copper.

Bordeaux Dont's. Don't use iron or tin vessels for mixing; don't use air slacked lime; don't pour in the coarser particles of lime; don't make more than can be used the same day.

Bordeaux mixture leaves a stain which persists for some time; this is objectionable where spraying is to be done near the time of the gathering of fruit (there is no danger of poisoning, the stains are simply unsightly). For such spraying the following fungicide may be used.

Copper Carbonate Solution. This is made according to the following formula:

Copper carbonate . .	5 ounces.
Strong ammonia . .	3 pints.
Water to make . .	50 gallons.

Put the copper carbonate in a pail with a quart of water, mix thoroughly, then add slowly the ammonia diluted with half a pailful of water, stirring constantly, then add to the rest of the water.

Application of Fungicides. Fungicides are applied to the plant it is desired to protect most economically and effectually in the form of a mist-like spray. To accomplish this successfully two things are necessary: a force pump with an air chamber that will give a strong and continuous stream, and a nozzle that will break up the liquid into a fine spray.

Since the general adoption of spraying a great variety of spray pumps have been put upon the market by different firms, and there is no difficulty in obtaining a suitable one for any kind of work. The following are the principal types: A small pump attached or attachable to a pail or bucket is very convenient where only a small amount of spraying is to be done on

low-growing plants. The knapsack sprayer (see Fig. 1 on cover) consists of a pump attached to a copper or galvanized-iron tank of such size and shape that it can be carried on the back like a knapsack. This is a very useful form for plants, vines, and shrubs, under ten feet in height, except where a large quantity has to be treated.

The barrel pump is designed to be attached to a barrel or tank and is the most generally useful form for ordinary orchards, vineyards, and potato fields. Where a large amount of spraying has to be done a sprayer run by horse or steam power may be obtained.

A good nozzle is of great importance. It should break up the stream of liquid into fine particles. It should be so constructed that it does not readily clog and should be provided with some device for clearing in case clogging occurs, as it may do sometimes with the Bordeaux mixture. Among the numerous varieties of nozzles there are two types which will be found most useful: the Vermorel and the Bordeaux. The Vermorel produces the finer spray, the Bordeaux throws farther. As they are not expensive, it would be well to have both; but if only one is used, the Vermorel is recommended.

None of the pump makers, so far as we have seen their catalogues, furnish sufficient length of hose. Fifteen to twenty feet is the least that can be used with convenience in spraying potatoes and fruit trees, and we recommend a fifty-foot length. For spraying trees some means of raising the nozzle is necessary; a rigid extention to the hose is the best means. A cheap and satisfactory one consists of ten to twelve feet of quarter inch gas pipe on one end of which the nozzle is screwed, the other end being fitted to screw on to the hose. Extensions of different lengths will be found very convenient.

The barrel pump outfit (the pump should be attached to the head of the barrel) may be carried in almost any farm wagon which is at hand, a light one-horse rig being preferable. A convenient spray cart may be cheaply made by fastening a platform of boards or plank on the axle of a pair of forward wheels which are provided with strong thills. The platform can be made so as to be readily and quickly detached when the wheels are wanted for any other purpose. See Fig. 2.

SPECIAL DISEASES AND THEIR TREATMENT

As has already been said, each cultivated plant may serve as the host for numerous different species of fungi. Some fungi are found on one species of host plant exclusively; others live on two or more nearly related species. Illustrations of the former are the late blight of the potato and the black rot of the grape; of the latter, brown rot on peach and plum, and smut on oats and barley.

The symptoms of fungous diseases are various; sometimes the whole plant has a sickly appearance, being yellowish in color and poorly developed. More frequently the disease is manifested by the appearance of limited areas or spots, differing in color from the usual green of the part. The colors of the diseased areas may be red, orange, yellow, purple, brown, or black. Swellings and other deformities are common. It is sometimes difficult to distinguish between injuries due to fungi and those due to insects; but in case of the latter there is either consumption or disappearance of parts; or the insect in some stage may be discovered on careful examination with the naked eye. Most insects are large enough to be so detected, while fungi are so small that they require a magnifier to reveal their presence with certainty. It is important to know which cause is producing the mischief, for the treatment is different, fungicides will not serve for insecticides, nor insecticides for fungicides.

The following list of diseases embraces only the more important ones occurring in New Hampshire:

APPLE

Apple Scab. Dark green or black, round velvety spots on the fruit; the spots are of appreciable thickness, justifying the name "scab"; the fungus develops just under the outer layer of the skin, remnants of which, as whitish scales, may often be seen on the surface of the scab; appears early in the season; fruit may drop off or become one-sided and cracked. On the leaves the fungus appears as dark green rounded patches.

Treatment. Spray with Bordeaux mixture as the buds are

opening; again just after the petals have fallen; a third time two weeks later. At the second spraying four ounces of paris green may be added to a barrel of the mixture for the codling moth.

Some varieties of apple are more susceptible to this disease than others; the Fameuse and Mackintosh Red are probably the most so, but the majority of varieties are likely to suffer more or less when the disease is especially prevalent as it was in 1902. A cold, damp season seems to be favorable to the development of the scab fungus. The scab is one of the diseases which is most effectually and profitably treated by spraying. The following is a summary of the results we have obtained:

On Fameuse apples.

	Unsprayed.	Sprayed.
Free from scab . .	29 per cent.	65 per cent.
Slightly scabby . .	48 " "	24 " "
Badly scabby . .	23 " "	11 " "
On Baldwins.		
Free from scab . .	67 " "	97 " "
More or less scabby . .	33 " "	3 " "
Free from scab . .	21 " "	81 " "
More or less scabby . .	79 " "	19 " "
Free from scab . .	20 " "	66 " "
Traces of scab . .	34 " "	28 " "
Badly scabby . .	46 " "	6 " "

The last figures show the result obtained in 1902. The scab was much more prevalent than it had been for at least the last ten or twelve years; this probably owing to the peculiar weather conditions. Almost all of the standard varieties suffered more or less.

Sooty Spot. Rounded dark colored or black spots on the fruit; at first sight resembling scab, but on closer examination seen to be more of the nature of a stain than a thick scab; lies wholly on the surface of the skin; appears usually after midsummer; gives the fruit a dirty, unsightly appearance.

Treatment. Trees sprayed for scab will be protected from

this disease; when it alone is to be treated, it is claimed that one spraying with Bordeaux mixture when the apples are the size of a hickory nut will prevent it.

Results of treatment as for scab:

On Greenings.

	Unsprayed.	Sprayed.
Free from spots . .	18 per cent.	77 per cent.
Slightly spotted . .	57 " "	23 " "
Badly spotted . .	25 " "	0 " "

On Baldwins.

Free from spots . .	17 per cent.	83 per cent.
Slightly spotted . .	63 " "	14 " "
Badly spotted . .	20 " "	3 " "
Free from spots . .	17 " "	66 " "
Slightly spotted . .	67 " "	32 " "
Badly spotted . .	16 " "	2 " "

The last figures result of 1902.

Brown Spot of Baldwin. Small circular brown spots on the fruit; surface of spot slightly depressed; looks like the beginning of rot; appears late in the season. This disease seems to attack the Baldwin almost exclusively; its chief injury, according to our observations, is to the appearance of the fruit.

Treatment. The same treatment as for scab has proved effective for the brown spot. A summary of results follows:

	Unsprayed.	Sprayed.
Free from spots . .	45 per cent.	97 per cent.
Spotted	55 " "	3 " "
Free from spots . .	32 " "	90 " "
Spotted	68 " "	10 " "
Free from spots . .	48 " "	78 " "
Spotted	52 " "	22 " "

Leaf Spot. Small, circular, sharply defined brown spots on the leaves. The apple trees in the vicinity of Durham have been more or less affected with this disease every year. It seemed much more abundant in 1902 than before; inquiries from different parts of the state were also received in regard

to it. Dropping of the leaves apparently from this cause were reported in several instances.

Treatment. We have none to recommend at present, as spraying with Bordeaux mixture has seemed to have but little effect in preventing it.

The results given above are on the basis of the effect of the spraying on the fungus. The following results are from some of the same apples but on a commercial basis:

I.	No. 1 . . .	58 per cent.	79 per cent.
	No. 2 . . .	23 " "	14 " "
	No. 3 . . .	19 " "	7 " "
II.	No. 1 . . .	20 " "	36 " "
	No. 2 . . .	58 " "	42 " "
	No. 3 . . .	22 " "	22 " "
III.	No. 1 . . .	10 " "	53 " "
	Nos. 2 and 3 . .	90 " "	47 " "
IV.	No. 1 . . .	25 " "	59 " "
	No. 2 . . .	48 " "	32 " "
	No. 3 . . .	27 " "	9 " "

The cost of spraying apple trees three times with Bordeaux mixture is from 10 to 15 cents per tree. The profit or loss by the operation will depend upon a number of conditions, more particularly: variety, prevalence of disease, quantity and value of apples produced.

If we assume that Baldwin trees produce 3 barrels each, that it costs 12 cents apiece to spray them, and that the apples are worth for firsts, seconds, and thirds (without barrels), respectively, $1.00, 50 cents, and 20 cents, the percentages given above will give as net profit per tree of spraying: I, 30 cents; II, 12 cents; III, 39 cents; IV, 55 cents; the average being 34 cents.

BLACKBERRY

Blackberry Rust. Affected plants have yellowish, sickly appearance; under side of leaves covered with bright orange powdery spore patches.

Treatment. Diseased plants should be dug up and destroyed as soon as detected.

CHERRY

For diseases of cherry and their treatment see Plum.

CORN

Corn Smut. Grayish white swellings on almost any part of the plant which develop into black powdery spore masses.

Treatment. No practical method of prevention has been demonstrated. The recommendations are to plant the least susceptible varieties, and to gather and destroy the spore masses.

CUCUMBER

Downy Mildew. Attacks leaves, which show yellow spots with mold-like growth on the under side; spots turn brown and the leaf soon dies.

Treatment. Spray with Bordeaux mixture about the middle of July and repeat every ten days.

During the past two seasons this disease has been very serious. The cucumbers in the Experiment Station garden in 1902 were sprayed five times and remained healthy until killed by frost. Unsprayed vines died two to three weeks earlier. The disease made its appearance considerably later than the previous year; not until after the middle of August.

GRAPE

Downy Mildew and Brown Rot. This disease receives the former name when attacking the leaves, the latter when attacking the fruit. On leaves, yellowish spots covered on the under side with whitish downy mold-like growth; leaves soon die and drop off. On fruit, later turning gray from development of spores.

Treatment. Spray with Bordeaux mixture just before leaf buds open, again just before flower buds open, a third time as soon as the fruit has set, a fourth time two weeks later, using copper carbonate solution instead of Bordeaux; it may be advisable to spray again with copper carbonate when the fruit is beginning to color.

Black Rot. Reddish brown spots on leaves. Grapes turn brown, finally black; becomes dry and shriveled with sharp

angular edges, and roughened with minute pimples which contain the spores.

Treatment. The same as for downy mildew.

MUSKMELONS

Muskmelons often suffer from downy mildew. The appearance of the disease and treatment are the same as for cucumber. Similar results to those reported under cucumber were obtained by spraying muskmelons in 1902.

OATS

Oat Smut. Affected plants usually smaller than healthy ones; but the disease is difficult to detect until the oats have "headed out," when in place of sound grain there appear black powdery masses which are composed of spores. The oat plant is infected shortly after germination by spores which are usually sown with the grain.

Treatment. This consists in destroying, before it is sown, the spores which adhere to the grain. This may be done by soaking the seed in a solution of formalin, one pint to fifty gallons, for two hours. The seed may also be treated by sprinkling with this solution, thoroughly wetting it and allowing it to remain in a heap for several hours.

PEACH

Leaf Curl. Early in season leaves become curled, wrinkled, or puckered; later wrinkled surface takes on a whitish or frosted appearance. Leaves turn yellow and drop off.

Treatment. Spray thoroughly with Bordeaux mixture a short time previous (two weeks) to the opening of the buds.

Peach Yellows. The following is Lodeman's description: "The trees first ripen their fruit prematurely, the peaches possessing distinct red streaks extending from the surface towards the pit. The following years the new growth is generally tufted, and branched shoots are produced from wood which is more than two years old. Such growths have narrow horizontal leaves, which are yellowish in color. The disease is contagious, and affected trees should be burned as soon as the disease is discovered. No cure is known."

PEAR

Pear Scab and Sooty Spot. These diseases seriously injure certain varieties of pears. Their appearance, effect, and treatment are the same as in the case of the apple.

Results of spraying with Bordeaux mixture for scab:

	Unsprayed.	Sprayed.	Sprayed.
Flemish Beauty.			
No. 1	5 per cent.	70 per cent.	58 per cent.
No. 2	12 " "	28 " "	38 " "
No. 3	83 " "	2 " "	4 " "
Sheldon.			
No. 1	29 " "	67 " "	76 " "
No. 2	42 " "	30 " "	16 " "
No. 3	29 " "	3 " "	8 " "

Pear Blight or Fire Blight. Leaves and twigs turn black and die; caused by bacteria; sometimes a very serious disease.

Treatment. Cut off and burn all diseased parts as soon as discovered, taking care to cut well below the seat of the disease.

PLUM

Black Knot. Swellings on the limbs and twigs in spring followed by cracking open of bark; exposed surface soon covered by dark green velvety growth, producing spores; succeeded by development of characteristic hard, rough, black knot in which is produced another crop of spores, mature about midwinter.

Treatment. We have found that spraying with Bordeaux mixture reduced the number of the knots about 25 per cent. The most effective remedy, however, is cutting out the swellings and knots as soon as they are discovered. The trees should be carefully examined in the spring and fall when not in leaf. The removed knots should be burned.

Brown Rot. Rotting of the fruit at or just before the time of ripening, accompanied by the development of grayish powdery tufts on the rotted areas.

Treatment. This is a very serious disease, and one difficult to prevent; the damage may be lessened by spraying. The

trees should be disinfected by a thorough spraying with Bordeaux mixture before the buds open; a second spraying should be given just after the fruit has set. As ripening approaches the spraying should be repeated at intervals of a week or ten days, using the solution of copper carbonate instead of Bordeaux to avoid staining the fruit. The rotting plums should be thoroughly gathered and burned.

The above spraying will also be useful in checking the black knot and the disease known as "*shot hole*." This is a disease in which the fungus kills a small circular area of the leaf, which later drops out leaving a "shot hole."

The cherry is attacked also by these diseases and may be treated in the same way.

POTATO

Early Blight. Dark brown or black spots with sharp margins upon the leaves, increasing in size and number, finally killing the vines; usually appears on late potatoes the latter part of July.

Late Blight and Rot. Rapidly progressive wilting and dying of the leaves, a whitish mold-like growth appearing on the under side; accompanied by rotting of the tubers; appears in August.

These two diseases are frequently present together.

Treatment. Spray with Bordeaux mixture by the middle of July, a second time the first of August, a third time the middle of August. When bugs are present at either of these sprayings they may be killed by adding half a pound of paris green to a barrel of the Bordeaux.

There is no question of the profit of spraying potatoes in regions where these blights are prevalent. The cost of spraying an acre three times as above will vary from $6.00 to $9.00; a saving of twice that number of bushels will usually pay the cost. The following is the summary of nine experiments: Smallest number of bushels per acre saved by spraying 21, largest 82, average 49. Supposing the cost of spraying in each case to have been $9.00 per acre and the value of the potatoes to have been 50 cents per bushel: The profit would have ranged from $1.50 to $32.00 per acre, the average being